OREGON ENGINE REBUILDERS

TECHNICAL BULLETIN

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Those Mysterious Hot Spots

The AERA Technical Committee offers the following information to consider while examining possible reasons for head gasket failures. "Hot Spots", what are they, where do they come from and how do they damage head gaskets?

HOT SPOTS WHAT ARE THEY? Hot Spots are localized areas that are not being evenly cooled or areas that are receiving excessive heat from an abnormal condition.

WHERE DO THEY COME FROM? Hot spots in the cylinder head come from uneven cooling, which may be resulting from any one, or a combination of the following conditions:

1. Radiators that don't transfer coolant heat to the atmosphere as they did when they were new. Deposits inside the radiator deter proper heat transfer.
2. Lack of coolant circulation from water pumps with a loose impeller, or blades that are corroded or missing.
3. Air trapped within the cooling system because it was not bled off properly after filling the system. This is very important after engine rebuild when the system has been drained entirely.
4. Excessive combustion chamber temperatures that extend higher than the factory engineered OEM design limits.
5. An exhaust system that has excessive back pressure from a partially plugged catalytic converter or collapsed exhaust pipe. Most systems allow less than 3 psi at 2000 rpm. This could be consideration for original failure.

HOW DO HOT SPOTS DAMAGE HEAD GASKETS?
During engine operation these hot spots actually allow the head to flex (expand) towards the block at the overheated areas. That process crushes the head gasket against the block, making the gasket thinner at the overheated areas. As the engine cools down after the engine is turned off, the head casting returns to its original shape. This is why when you remove the head and check it for straightness, the head may not show excessive warpage. The gasket, however, now permanently damaged from being crushed past its design limits by the head casting flexing, cannot maintain the required combustion seal.

Restarting the cold engine allows very hot combustion gases under high pressure to blow across the webbed area between the cylinders and/or into the coolant passages. This occurs because the gasket was over compressed from the previous thermal expansion damage, which allows the gasket facing material outside the combustion seal to quickly degrade and erode away. This occurs most generally towards a coolant hole or passage, all resulting from a lack of combustion pressure seal to contain the hot combustion gases. The first conclusion though may be the gasket was defective upon installation which would be an incorrect assumption.

BUT IT NEVER RAN HOT.
The coolant temperature gauge will not indicate to the vehicle operator that there is a hot spot within the cylinder head casting. This is because the coolant temperature gauge indicates only

the average temperature of the fluid passing the sending unit. So, the operator just continues to operate the vehicle until total failure occurs.

In the illustration shown below, consider the tub similar to a four cylinder head with four heat sources. The area above the drain inside the bathtub is a hot air bubble created from a boiling effect. The head temperature at the head gasket surface of 400 to 650° F cannot be adequately removed because of these air pockets. The tub or head casting has no choice but to expand excessively from the higher than normal operating temperatures. Understanding how the damage occurs is only the first step, while repairing what caused the damage is the ultimate goal.

The tub shown in the illustration above shows four flames under it as a heat source, similar to a cylinder head with four exhaust valves. Looking at the tub you will notice one of the flames appears hotter than the others. Relate that to a cylinder head with one exhaust valve operating hotter than the others for yet unknown reasons. Imagine that overheated area of the coolant boiling, creating hot air pockets. Those voids prevent engine coolant from remaining in contact with the casting to cool the hot spots, thus, loosing control of cylinder head expansion at that particular location.

Observing the temperature indicated on the dashboard from the sending unit area, coolant temperatures of 180-190°F may appear to be normal. In reality, the damage is occurring with no external indicators to observe. That also includes coolant heat tabs as they do not melt until 255°F.

The AERA Technical Committee